

C3109
680-010514-US (PAR)

Patent Application Papers Of:

HUNG VIET NGO

For:

OPTICAL CONNECTOR ADAPTER WITH LATCH INSERTS

14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
2205
2206
2207
2208
2209
2210
2211
2212
2213
2214
2215
2216
2217
2

OPTICAL CONNECTOR ADAPTER WITH LATCH INSERTS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to optical connector adapters and, more particularly, to optical connector adapters having latch inserts.

2. Brief Description of Earlier Developments

Optical connector adapters are used generally for end to end mating of optical connectors. Optical connectors intended to be mated to each other are inserted into the adapter. The adapter aligns and positions the connectors relative to each other to effect a connection. The adapters include receptacles into which the connectors are inserted, and it is the receptacles that accurately position the connectors relative to each other. Also, the receptacles may have locking features which lock the connectors to the adapter, and hence, to each other. Conventional adapters are made in pieces. For example, the conventional adapter may have an outer frame with features, such as flanges, for mounting the adapter to printed circuit boards (PCBs) or the chassis of electronic devices. The inner receptacles of the adapter may be molded separately from the outer frame. Having the receptacles made apart from the outer frame allows the receptacles to be shaped more accurately to better interface with the connector inserted therein, and also simplifies manufacture of both the outer frame and the inner receptacles. This in turn reduces manufacturing costs. However, the outer frame of the adapter is sectioned in order to facilitate installation of the

inner receptacles into the outer frame. For example, the adapter frame may be sectioned into halves. The receptacle may be inserted into each half, such as by press fitting the receptacle into the appropriate half frame. Then, the half frames, with the receptacles therein may be bonded to each other by means such as ultrasonic bonding. This method is likely to result in misalignment between the receptacles in the adapter. This may be caused by small differences in the positioning of the receptacles in the frame halves, which are compounded when the position of one receptacle is related to the adjoining receptacles. Also, some misalignment between receptacles may be introduced when the adapter halves are mated and then bonded. The misalignment between receptacles in turn causes misalignment between mating connectors inside the adapter thereby degrading the connection between connectors. One example of an optical connector adapter is disclosed in U.S. Patent No. 5,317,663, which provides an adapter for holding coaxially aligned connectors. The adapter here has a main body with a side opening for installing a inner housing into the main body. The opening in the main body is covered with a panel. The large opening reduces the rigidity of the main body in this adapter. U.S. Patent No. 5,563,971 discloses another example of a conventional optical adapter comprising first and second receptacle members and separate alignment sleeves located in the receptacle members. U.S. Patent No. 5,774,611 discloses still another example of a conventional adapter comprising an outer part and an inner part fixedly held in the outer part. The inner part is one molding which may be difficult and costly to produce especially in the case of larger multi-fiber optical connectors. The present invention overcomes the problems of conventional

adapters for all connector types (i.e. SC, LP, MTP, or MPO connectors).

SUMMARY OF THE INVENTION

5

10

15

20

25

30

In accordance with the first embodiment of the present invention, an optical connector adapter is provided. The optical connector adapter comprises a housing, and a pair of latch inserts. The housing has at least one passage formed therein for receiving a pair of connectors adapted to be mated to each other. The pair of latch inserts is located in the at least one passage of the housing. Each latch insert is adapted for locking a corresponding connector of the pair of connectors to the housing. At least one latch insert has a spring loaded projection. The housing has at least one detent formed therein. The spring loaded projection on the at least one latch insert is biased into the at least one detent locking the at least one latch insert to the housing.

In accordance with the second embodiment of the present invention, an optical connector adapter is provided. The adapter comprises an outer housing, and a pair of inner housings. The outer housing has at least one passage extending through the outer housing for mating a pair of opposing connectors therein. The pair of inner housings is located in the at least one passage. Each inner housing has a receptacle for receiving a corresponding connector of the pair of connectors. Each housing has a latch for locking the corresponding connector to the inner housing. The outer housing is a one-piece member. The pair of inner housings is inserted into the at least one passage from opposite ends of the passage.

In accordance with another embodiment of the present invention, an optical connector adapter is provided. The adapter comprises an outer housing, and a pair of inner connector receptacles. The outer housing has at least one passage extending through the housing for mating a pair of opposing connectors therein. The pair of inner connector's receptacles is located in the passage. Each inner connector receptacle is adapted for receiving a corresponding connector. The connector receptacle is adapted for locking the corresponding connector to the outer housing. The outer housing has a pair of guide rails for guiding insertion of the pair of inner connector receptacles into the passage. A first one of the guide rails allows insertion of the first one of the inner connector receptacles through only one end of the passage. A second one of the guide rails allows insertion of a second one of the inner connector receptacles through only an opposite end of the passage.

In accordance with a method of the present invention, a method for fabricating a optical connector adapter is provided. The method comprises the steps of providing an outer housing, inserting a first inner housing into the outer housing, securing the first inner housing to the outer housing, inserting a second inner housing into the outer housing, and securing the second inner housing to the outer housing. The outer housing is provided as a one-piece member. The outer housing is adapted for mating a pair of optical connectors therein. The outer housing has at least one passage extending through the housing. The first inner housing is inserted into the passage. The first inner housing has a first receptacle adapted for receiving the first connector therein. The second inner housing is inserted into the at least one

passage. The second inner housing has a second receptacle adapted for receiving a second connector therein. The first and second inner housings are inserted into the passage through opposite ends of the passage.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing aspects and other features of the present invention are explained in the following description, taken in connection with the accompanying drawings, wherein:

Fig. 1 is a perspective view of an optical connector adapter assembly incorporating features of the present invention, a back panel B, and a connectorized optical conductor C, the adapter assembly is shown mounted to the back panel B, and the conductor is shown removed from the adapter assembly;

Fig. 2 is another perspective view of the optical connector adapter assembly in Fig. 1;

Fig. 3 is an exploded view of the optical connector adapter assembly in Fig. 1;

Fig. 4 is a cross-sectional elevation view of the optical connector adapter assembly taken along line 4-4 in Fig. 2;

Fig. 5 is another cross-sectional elevation view of the optical connector adapter assembly in Fig. 2;

Fig. 6 is an exploded perspective view of an optical connector adapter assembly in accordance with another preferred embodiment of the present invention; and

Fig. 7 is yet another exploded perspective view of an optical connector adapter assembly in accordance with still another preferred embodiment of the present invention.

5

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Fig. 1, there is shown a perspective view of an optical connector adapter assembly 10 incorporating features of the present invention, a back panel B and a connectorized optical conductor C. Although the present invention will be described with reference to the drawings, it should be understood that the present invention can be embodied in many alternate forms of embodiments. In addition, any suitable size, shape or type of elements or materials could be used.

In Fig. 1, the optical connector adapter assembly 10 is shown mounted to the back panel B. The connectorized optical conductor C is shown removed from the adapter. The connectorized optical conductor C has a connector C10 which is intended to be mated end to end to the connector of another conductor (not shown) inside the adapter assembly 10.

Panel B, of which only a portion is shown in Fig. 1, for example purposes, may be the back panel or part of the chassis of an electronic device (not shown), or may be part of a printed circuit board of the device. Panel B may have an architecture that allows any number of connectorized optical conductor assemblies to be connected thereto, although Fig. 1 shows one adapter assembly 10 mounted to panel B for example purposes. As noted before, the connectorized conductor assembly C

generally comprises conductor T and connector C10. The conductor T may be a multi-fiber optical conductor having a number of optical conductor fibers (not shown) therein. The optical conductor fibers of the conductor T are
5 terminated in connector C10. Connector C10 may be for example an MPO or MTP type connector. The present invention will be described below with particular reference to adapters for mating MTP or MPO type connectors. However, the present invention is equally
10 applicable to any other type of adapter used for mating any desirable type of connector (such as SC, or LP connectors).

In this case, the optical connector C10 of cable assembly C, generally includes an outer housing C12, a release
15 slide C14, and an inner ferrule C16. The inner ferrule C16 is located inside the housing C12 and holds the terminal ends of the optical fibers in the conductor C. A portion of the ferrule extends out at the front end C18 of the connector. The terminals of the optical fibers
20 may be aligned in a row. The ferrule may hold as little as four or up to twelve or more terminals. The ferrule may be provided with a number of conventional guide pins (not shown) at the front end C18 which help interface the connector C10 to a mating connector inside the adapter.
25 The outer housing C12 may be a plastic molding. As can be realized from Fig. 1, the housing C12 has a generally rectangular shape, although in alternate embodiments, the connector housing may have any other suitable shape. One side C20 of the housing C12 has a projecting key or guide
30 C22 used for aiding insertion of the connector into the adapter assembly 10. According to the invention, the housing C12 also has recesses or detents, which are engaged by latches on the adapter described further

below, to lock the connector C10 into the adapter. The recesses C24 may be located on opposite sides of the connector. The slide release C14 is slidably mounted on the outer housing C12 as shown in Fig. 1. The slide release C14 is preferably spring loaded along the housing C12 by any suitable spring (not shown). The spring biases the slide C14 towards the front C18 of the connector C10. The user moves the slide release C14 toward the rear C28 in order to release the latches on the adapter from the connector and thus release the connector from the adapter.

Referring now also to Figs. 2 and 3, the optical connector adapter assembly 10 according to the invention, will be described, and generally comprises an outer housing 12, inner latch inserts or housings 14A, 14B, and in one embodiment a cover or door 18. The latch inserts 14, 16 are located inside the outer housing 12. The cover 18 is mounted on the outer housing 12. The cover is pivotable so that it may be opened or closed. When in its closed position (not shown), the cover 18 covers one end 9 of the adapter housing 12. In alternate embodiments, the adapter assembly may not have a cover.

As seen in Fig. 3, the adapter 10 has a pair of inner latch inserts 14A, 14B. In the preferred embodiment, both latch inserts 14A, 14B are substantially the same. Accordingly, the description below will refer in particular to one latch insert 14A unless otherwise noted. Latch insert 14A is preferably a one-piece member made of plastic or any other suitable non-metallic material. The latch insert may be formed by injection molding or any other suitable forming process. The latch insert has a generally tubular or shell shape which

defines a receptacle or receiving area 20 therein. The receiving area 20 is shaped to conform to the exterior shape of the connector C10 so that the connector C10 and the inner surface 20S of the receiving area 20 form a close running or sliding fit. As seen in Fig. 3, the shell 22 of the latch insert 14A has a base section 24 at one end 25 and a flexible section 26 extending from the base section. The shell 22 has two narrow sides 28T, 28B which have a generally outwardly curved shape in the preferred embodiment (although in alternate embodiments the sides may be flat, or have any other suitable shape). The other sides 26L, 26R of the shell 22 are wider giving the shell a generally rectangular cross-section. One side 26 of the shell 22 has an outward protruding section 38 which extends longitudinally from one end 27 to the other end 25 of the shell 22 (protruding section 38 is seen more clearly on latch insert 14B in Fig. 3). The protruding section preferably has a general C shape with flat laterally projecting sides 40, 42 and a flat web 43 connecting the sides. In alternate embodiments, the outward projecting section may have any suitable shape and may extend for any desired length along the shell. The protruding section 38 defines a key on the outside of the shell and a guide channel 44 in the receiving area 20 of the latch insert 14A (14B). The guide channel 44 cooperates with the key C22 on the connector to aid insertion of the connector and alignment of the connector in the receiving area 20.

The base section 24 of the latch insert shell 22 has a continuous wall and thus is very rigid. The flexible section 26 has, as shown in Fig. 3 two pairs of opposing resiliently flexible arms 30, 34. In alternate embodiments, the flexible section of the latch insert

shell may have any suitable number of arms. One pair of flexible arms 30 is located on opposing sides 26L, 26R of the shell. The arms 30, 34 are included in the respective sides 28T, 28B, 26L, 26R of the shell. The arms may thus be formed during molding of the shell, or after molding by cutting partial slots into the respective sides of the shell to form the arms. Arms 30 in sides 28T, 28B are connector latch arms used for locking the connector C10 into the receiving area 20 of the latch insert 14A. Latch arms 30 have inwardly projecting latch teeth 32 which are shaped to engage recesses C24 in the connector housing (see Fig. 1). In the preferred embodiment, the latch teeth 32 are located at the respective distal ends 33 of the connector latch arms 30, though in alternate embodiments the latch teeth may be disposed at any suitable location along the latch arms.

Referring now also to Fig. 4, which is a cross-sectional view of the adapter assembly taken through line 4-4 in Fig. 2, latch arms 34 in sides 26 L, 26R also have latch teeth 36 located at the outer end of the arms. Latch teeth 36 project outwards from the shell 22. Each latch tooth 36 has a sloped camming surface 46 on one side and a stop surface on the opposite side. In one embodiment, the camming surface is facing end 25 of the shell, and the stop surface 48 is facing the opposite end 27 of the shell. In alternate embodiments, the camming and stop surfaces of the outward projecting teeth may have any other desired orientation. As seen in Fig. 3, teeth 36 may extend across the respective latch arms 34, though the teeth may be provided with any desirable width.

Still referring to Figs. 2-4, the outer housing 12 of the adapter assembly 10 is a one-piece member, which in the preferred embodiment may be made from plastic or any other suitable material. The one-piece housing may also
5 be made from metal such as aluminum alloy or steel such as in the case of a shielded connector. If made from plastic, the outer housing may be formed using any suitable molding process such as injection molding. In the case where the housing is metal, the housing may be
10 shaped by casting or drop forging. The outer housing 12 comprises a mounting section 50 and a housing section 52. As seen in Fig. 3, the housing section 50 has a general tubular shape with passage 68 extending through the housing. In the preferred embodiment, the passage 68 has
15 a general rectangular shape conforming to the outer surface 22S of the latch inserts 14A, 14B. As seen in Fig. 3, the passage is oriented so that the latch inserts 14A, 14B are held in a vertical position in the housing 12. In the vertical position, side 28T of the inserts
20 14A, 14B is facing the top side 50T of the housing. As seen best in Fig. 4, passage 68 has two guide channels or slots 70, 72. In the preferred embodiment, guide channel 70 is formed into side 50R of the housing. Channel 72 is formed into the opposite side 50L of the housing. Guide
25 channel 70 extends from one end 9 along the passage 68 into the housing and terminates in stop surface or edge 70S. As seen in Fig. 4, guide channel 72 is reciprocal to channel 70, extending from end 11 to stop 72S. The guide channels 70, 72 have a shape which conforms to the
30 projection section 38 on side 26R of the inserts 14A, 14B. The projecting section 38 of each insert 14A, 14B forms a close sliding fit with the inner surface of the corresponding guide channels 70, 72. The stop surfaces 70S, 72S in each guide channel 70, 72 are located to stop

insertion of the latch inserts when the inserts reach the installed position. In one embodiment, the stop surfaces 70S, 72S are substantially co-planar, located at about the midsection of the housing 12. This allows the latch inserts 14A, 14B to be abutted together. As seen in Fig. 4, in alternate embodiments, the stop surfaces in the respective guide channels may be located at some distance apart from each other, and may be located at any location along the passage 68. In another alternate embodiment, insertion stops for the latch inserts may be located on any side of the passage and outside the guide channel. In still other alternate embodiments, the guide channels may extend from one end of the passage to the other end.

As seen best in Figs. 3 and 4, the vertical side walls 50L, 50R have two pairs of apertures 74L, 74R, 76L, 76R. One pair of apertures 74L, 74R is located proximate end 9 of the housing section 50. The other pair 76L, 76R is proximate the other end 11 of the housing section. Apertures 74L, 74R, 76L, 76R extend through the respective side walls 50L, 50R into the passage 68. The apertures 74L, 74R, 76L, 76R are sized to admit therein, from passage 68, the latch teeth 36 on latch arms 34 of the latch inserts 14A, 14B. In alternate embodiments, the housing section 50 may have any suitable type of detents or recesses formed into the side of the passage to engage the outward projecting latch teeth of the latch inserts.

As seen in Fig. 3, the mounting section 52 is generally a flange which surrounds the tubular housing section 50. The mounting section 52 has a planar surface 54 which defines a seating surface for the mounting section. Referring also to Fig. 5, the housing section 52 and

mounting section are angled relative to each other so that the center line axis, or axis of symmetry 78 of passage 68 is angled relative to the plane or surface 54. In the preferred embodiment, the angle is about 45°. In
 5 alternate embodiments, any acute angle may be used. In other embodiments (see for example Fig. 7) the mounting section and flange may be orthogonal. In still other alternate embodiments, the mounting section need not be a continuous flange, but may be a sectioned flange or a
 10 number of flanges forming co-planar or parallel planar surfaces. The mounting section 52 has fastener holes 56 in both the top and bottom sections 58, 60. The mounting section 52 also may have a recess 61 formed into surface 54 for an EMI gasket (not shown). The recess 61 extends
 15 along side portions 62, and across top and bottom sections 58, 60, thereby surrounding the housing section 50. In alternate embodiments, a gasket recess may not be provided.

The cover 18 is preferably a one-piece member which is
 20 made of plastic or any other suitable material. The cover has a general L shape with a mounting or base section 82 and a cover section 84. In one embodiment, the base section is at the top and the cover section 84 depends from the base section. The base section may
 25 include a cover 86, with a bore (not shown) for a pivot pin (not shown). The clevis 86 is configured to interface with a bored lug (not shown) on the top side 50T of housing section 50. The pin may be inserted through the bores in the lug and clevis to pivotally
 30 mount the cover 18 to the housing 50. The cover may be pivoted in the direction of arrow P between the open position shown in Fig. 3 and a closed position (not shown). A spring (not shown) such as a helically wound

torsion spring, may be placed around the pin to bias the cover 18 towards the closed position. The cover section 84 depending from the base section 82 is of sufficient length and width to cover the opening of passage 68 in end 9 when the cover is in the closed position.

The adapter may be assembled merely by sliding the latch inserts 14A, 14B into the passage 68 of the housing section 50. Latch insert 14A is inserted into the passage 68 with end 25 first through the opening in end 9 of the housing. The projecting section 38 on the side 26R of the latch insert is received into the guide channel 70. Thus, the projecting section 38 on the latch insert 14A and the guide channel 70 form polarizing features which allow insertion of the insert through end 9 in the desired orientation. The insert 14A is inserted into the passage to the stop surface 20S. When abutted against the stop surface 70S, the insert 14A is located in its installed position as shown in Figs. 4-5. During insertion, the camming surfaces 46 on the latch teeth 36 of latch arms 34 come into contact with the sidewalls of the passage. This causes the resiliently flexible arms 34 to be resiliently deflected inwards. As seen best in Fig. 4, when the insert 14A is in the installed position, the latch teeth 36 are aligned with corresponding apertures 74L, 74R. This allows the inwardly deflected latch arms 34 to resile outwards thereby inserting the latch teeth 36 into the corresponding apertures 74L, 74R. With the latch teeth 36 in the apertures, stop surface 48 on the teeth engages the edge 82L, 82R of the apertures preventing the insert from being withdrawn. Hence, in the installed position, insert 14A is clamped in the housing 50 between stop surface 70S on one side and the edge 82L, 84R of the apertures 74L, 74R on the other side

*sub
A' /
control*

5 (see Fig. 4). Insertion of latch teeth 36 into apertures 74L, 74R may provide an aural indication (i.e. a "snap") to the user that the insert 14A has been successfully installed. The open apertures 74L, 74R also allow the user to visually verify if installation is complete by checking to see if teeth 36 have been fully inserted into the apertures.

10 As seen in Figs. 4 and 5, in the installed positions, the exterior 22S of the base section 22 of the latch insert contacts the interior surface 68I of the passage 68 all around the periphery of the base section. This ensures that the latch insert and in particular the centerline axis 20C of the receiving area 20 in insert 14A, is

15 aligned with the centerline axis 78 of the passage.

Installation of the second latch insert 14 into the housing 50 is substantially similar to that described before with respect to insert 14A. Latch insert 14B is

20 facing opposite from insert 14A, and is inserted into the passage 68 through the opening in end 11 of the housing. As seen in Fig. 4, guide channel 72 is located on sidewall 50L of the housing 50. Accordingly, insert 14B is rotated 180° about its centerline axis 20D relative to

25 insert 14A in order to align projecting section 38 with guide channel 72. The insert 14B may then be inserted to the stop surface 72S which places the insert 14B in the installed position (see Fig. 4). The latch arms bias the latching teeth into apertures 76L, 76R locking the insert

30 14B into the housing section 50. As seen in Fig. 4, the latch inserts 14A, 14B are abutted against each other. The base section of latch insert 14B also interfaces with the inner surface 68I of the passage 68 so that the centerline axis 200 of the receiving area is aligned with

axis 78 of the passage. Accordingly, the centerline axis 20C, 20D of the respective latch inserts are aligned with each other.

5 The adapter assembly 10 may be mated to the panel B by inserting a rear portion 51 of the adapter housing 50 through hole B3 in the panel. The planar surface 54 on the mounting section 52 is seated against the panel B. If desired, an EMI gasket (not shown) may be placed into
 10 recess 61 on the mounting section 50 before mounting the adapter to the panel. The adapter 10 may be secured to the panel B with suitable fasteners 91, such as machine screws, inserted through holes in the panel into fastener holes 56 on the mounting section. As shown in Fig. 1,
 15 when the adapter 10 is mounted to the panel B, the centerline axis 78 of the passage 68, and as noted before, also of the receiving areas 20 in the latch inserts 14A, 14B, is pitched relative to the panel B. The connector C10 is inserted into the adapter along axis
 20 78. The connector C10 is received into the receiving area 20 of the latch insert 14A. The guide channel 44 in the receiving area allows insertion of the connector when the projecting key C22 of the connector C10 is aligned with the guide channel 44. When the connector C10
 25 reaches the installed position spring latches 32 automatically engage the recesses C24 on the connector to lock the connector inside the receiving area. An opposing connector (not shown) may be inserted in a similar manner into the receiving area of the second
 30 latch insert 14B.

As noted before, the receiving areas of the two latch inserts 14A, 14B are precisely aligned with each other by the one-piece outer housing 50 of the adapter. Hence,

the opposing connectors inside the receiving area are also precisely aligned. This allows the ends of the connectors to be connected resulting in a connection of high fidelity. As can be realized, adapter assembly 10 has many advantages over conventional adapters. One advantage with respect to conventional adapters having sectioned outer housings is that adapter 10 eliminates any bonding or securing of housing sections together. After installation of the latch inserts 14A, 14B into the one-piece housing, the adapter assembly is complete. No further time and hence cost need be expended in order to secure sections of the outer housing together as in conventional adapters. In the case of conventional adapters with bonded housing section, additional expense and time is spent in the bonding process. Also, errors in alignment of the housing sections, and hence of the connector receiving areas in the different housing sections, may be introduced during the positioning of the housing sections prior to bonding. Precise alignment of housing sections in conventional adapters may be especially difficult in the case where the mounting section and housing section of the adapter are slanted relative to one another (similar to adapter 10 in Fig. 1). The bonding seam or interface in such conventional connectors is generally located at or along the mounting section. Thus, the bonding interface may itself be pitched relative to either the mounting section or housing section of such conventional adapters. In this case special tooling may have to be used to ensure precise alignment of the housing section prior to bonding. These problems are resolved by adapter assembly 10.

Referring now to Fig. 6, there is shown a connector adapter assembly 110 in accordance with another embodiment of the present invention. Except as otherwise noted below, adapter assembly 110 is generally similar to assembly 10 described previously and shown in Figs. 1-5. Similar features are similarly numbered. Assembly 110 comprises outer housing 112, latch insert 114A, 114B and cover 118. The adapter 110 is also shown as an angled adapter wherein when the adapter is mounted to a panel (similar to adapter 10 mounted to panel B in Fig. 1), the centerline axis 178 of the receiving area 120 is angled relative to an axis normal to the panel. The outer housing 112 comprises mounting section 152 and housing section 150. The outer housing is a one piece member which may be a plastic injection molding or may be cast or otherwise formed by any suitable method such as drop forging from metal. The housing section 150 has passage 168 extending through the housing section. The passage has centerline axis 178 which, as seen in Fig. 6, is angled relative to the mounting section 152 and planar surface 154. The passage 168 is sized so that inner latch inserts 114A, 114B can slide respectively into the passage 168 from opposite ends 109, 111 of the housing. In this case, the passage 168 is oriented so that the latch inserts are positioned in the housing in a horizontal position. As seen in Fig. 6, one of the guide channel 170 which polarizes the orientation of the insert 114A in the passage 168, is located in the bottom side 150B of the housing. The second guide channel (not visible in Fig. 6) for guiding insert 114B into the passage 168 may be formed into the top side 150T of the housing. Latch apertures 174 (only one is visible in Fig. 6) for latching the inserts 114A, 114B into the housing are located in this embodiment in the top 150T

and bottom 150B sides of the housings. The latch inserts 114A, 114B are substantially identical to inserts 14A, 14B. In the embodiment shown in Fig. 6, the latch inserts 114A, 114B are rotated 90° about their longitudinal axis (i.e. the latch inserts 114A, 114B are shown in a horizontal position) in comparison to the latch inserts 14A, 14B depicted in Figs. 1 and 3. The latch inserts 114A, 114B have resiliently flexible latch arms 130, with projections 136 to engage apertures 174 and lock the inserts to the housing. When installed into passage 168, the centerline axes 120C, 120D of the receiving areas 120 of the inserts 114A, 114B are aligned with centerline axis 178 of passage 168. Hence, the receiving area 120 of the inserts are also accurately aligned with each other. Cover 118 is pivotably mounted to one end 109 of the adapter, and can be pivoted to a closed position where the cover 118 covers the opening to passage 168.

Referring now to Fig. 7, there is shown an adapter assembly 210 in accordance with another preferred embodiment of the present invention. Except as otherwise noted, adapter assembly 210 is generally similar to adapter assembly 10 described before and shown in Figs. 1-5. Hence, similar features are similarly numbered. The adapter assembly comprises an outer housing 212 and pairs of opposing latch inserts 214A1, 214B1, 214A2, 214B2, 214A3, 214B3 located therein. In the embodiment shown in Fig. 7, the adapter 210 is adapted for accommodating multiple pairs of connectors (each connector being similar to connector C10 in Fig. 1) intended to be connected end to end to respective mating connectors (not shown) inside the adapter 210. Accordingly, the outer housing 212 of the adapter has

multiple passage 268A, 268B, 268C. The housing 212 in Fig. 7 is shown as having three passages 268A, 268B, 268C for example purposes, and in alternate embodiments the housing may have any desired number of passages. As can be realized from Fig. 7, the passages 268A, 268B, 268C are disposed so that the latch inserts 214A1, 214B1, 214A2, 214B2, 214A3, 214B3 are held in a vertical position. The latch inserts 214A1, 214B1, 214A2, 214B2, 214A3, 214B3 are substantially the same as latch inserts 14A, 14B described before and shown in Figs. 3-5. The outer housing 212 is a one-piece member molded from plastic, or in the case of a shielded adapter, shaped from metal such as aluminum alloy or steel. The outer housing 212 comprises mounting section 252 and housing section 250. As stated before, the housing section 250 has passages 268A, 268B, 268C which extend through the housing section 250 from one end 209 to another 211. All passages 268A, 268B, 268C are substantially similar to each other. Housing section 250 has interstitial walls 265A, 265B separating the passages. Each passage has two guide channels therein (only the guide channels 270A, 270B, 270C on one side of the housing are visible in Fig. 7) for guiding insertion of the corresponding pairs 214A1, 214B1; 214A2, 214B2; 214A3, 214B3 into the respective passages 268A, 268B, 268C. Latch apertures 274L, 274A, 274B, 274R (only the latch apertures on one side of the housing are visible in Fig 7) are provided in the housing walls 250L, 265A, 265B, 250R to engage the spring loaded latch teeth 236A, 236B, 236C on the latch inserts. Latch apertures 274A, 274B are respectively located in interstitial walls 265A, 265B. As can be realized from Fig. 7, these intermediate apertures 274A, 274B are each engaged by two latch teeth (e.g. aperture 274A is engaged by one latch tooth 236A of insert 214A1,

and on the other side by latch tooth 236B of insert 214A2). Accordingly, the latch apertures 274A, 274B have sufficient depth to allow full engagement of the latch teeth into the apertures.

5 The adapter 210 is assembled in a manner substantially similar to that previously described for adapter 10 in Figs. 1-3. Each pairs of inserts 214A1, 214B1, 214A2, 214B2, 214A3, 214B3, is inserted into the corresponding passage 268A, 268B, 268C, from opposite ends 209, 211 of the housing section 250. Upon reaching their installed position, the spring loaded latch teeth 236A, 236B, 236C, of the respective latch inserts automatically engage the apertures 274L, 274A, 274B, 274R in the housing locking the latch inserts in the housing. The one-piece member housing 250 ensures that the latch inserts in each and every passage (e.g. inserts 214A1, 214B1, in passage 268A, inserts 214A2, 214B2, in passage 268B, and inserts 214A3, 214B3, in passage 268C,) of the housing are aligned with each other allowing accurate mating of the connectors inserted into the latch inserts. This is not the case with conventional optical connector adapters having multiple passages. For example, in the conventional adapters, any misalignment between housing sections that occurs during bonding is compounded when extended to the multiple passages in the adapter. Thus, a minor misalignment at one point is magnified when taken to the other locations of the housing. In adapter 210 shown in Fig. 7, the opposing latch inserts are always properly aligned for each and every passage in the adapter housing.

It should be understood that the foregoing description is only illustrative of the invention. Various alternatives

and modifications can be devised by those skilled in the art without departing from the invention. Accordingly, the present invention is intended to embrace all such alternatives, modifications and variances which fall
5 within the scope of the appended claims.

11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
2205
2206
2207
2208
2209
2210
2211
2212
2213
2214
2215
2216
2217
2218
2219
2220
2221
2222
2223
2224
2225
2226
2227
2228
2229
2230
2231